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CHICAGO UNIV ILL DEPT OF CHEMISTRY
ION-ION NEUTRALIZATION PROCESSES AND THEIR CONSEQUENCES.(U)
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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER 1 (19) 16945.1-C (18) ARD AD-A 099 905	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) (6) Ion-Ion Neutralization Processes and their Consequences		5. TYPE OF REPORT & PERIOD COVERED 9 Final Report 1 Jun 80 - 28 Feb 81
7. AUTHOR(s) (11) R. Stephen/Berry		6. PERFORMING ORG. REPORT NUMBER
9. PERFORMING ORGANIZATION NAME AND ADDRESS Department of Chemistry The University of Chicago 5735 S. Ellis Avenue, Chicago, Illinois 60637		8. CONTRACT OR GRANT NUMBER(s) Contract DAAG 2980 K0016 new
11. CONTROLLING OFFICE NAME AND ADDRESS U. S. Army Research Office Post Office Box 12211 Research Triangle Park, NC 27709		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS (13) DAAG 29-81-1-01
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) (11) 11 11 11 LEVEL		12. REPORT DATE May 11, 1981
		13. NUMBER OF PAGES 3
		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report) NA		
18. SUPPLEMENTARY NOTES The view, opinions, and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other documentation.		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Shock tube, laser, ion neutralization kinetics, alkali halide, sodium iodide, spectroscopy, dissociation, charge transfer		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This final report summarizes the status of the studies of the kinetics of dissociation and chemical relaxation of alkali halides in shock-heated vapors, and of the light emission processes that occur in such systems. These include light amplification in the wings of atomic lines of sodium and rubidium.		

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ION-ION NEUTRALIZATION PROCESSES AND THEIR CONSEQUENCES

FINAL REPORT

R. Stephen Berry

May 11, 1981

U.S. ARMY RESEARCH OFFICE

CONTRACT DAAG 2980 K0016

THE UNIVERSITY OF CHICAGO

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FINAL TECHNICAL REPORT

The research conducted under this Contract consisted of two parts:

1) The completion of the analysis of the chemical kinetics of dissociation and subsequent reactions of alkali halide vapors in argon, shock-heated to temperatures between 3500 and 6500 K;

2) The verification and further study of the intense single pulses, quasiperiodic pulses and amplification of visible light in the region of spectral lines of alkali atoms, as had been reported in our earlier work conducted under contracts with the Army Research Office.

The chemical kinetics study constituted the doctoral research of Joseph Weber. This extensive study is now complete and is being prepared for submission for publication. The results of this magnum opus are a kinetic model and a large set of rate coefficients for collisional dissociation, charge exchange, collisional detachment, collisional ionization and for the inverses of these processes, for all the combinations of rubidium and cesium with chlorine, bromine and iodine. Where the results overlap with previous shock tube and flame studies, or, for the most part, with colliding-beam studies of these reactions, the results are in quite good agreement. The interdependence of the net of reactions involved in our study leaves virtually no ambiguity in the choice of rate coefficients and model. The results, therefore, must be among the firmest examples of the inference of a mechanism from measurements of reaction rates. The one major discrepancy between all the shock tube studies and the beam collision work is in the rate of collisional detachment of electrons from halide ions by argon. The inference we draw here is that the process represented as

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$\text{Ar} + \text{Cl}^- \rightarrow \text{Ar} + \text{Cl} + \text{e}$, for example, for analysis of the shock tube studies is in reality a more complex reaction having the net overall stoichiometry of the simple collision process.

The studies of the pulsed and amplified radiation were underway when this Contract ended. At the close of the Contract, we had established that the intense pulses of yellow light from Na(3p) can be reproduced under controlled conditions. We were beginning to make observations of the light emission from wings of the sodium D-line and several rubidium lines. We had previously reported amplification in the blue wings of these lines. The work in progress at the conclusion of this Contract showed emission in the red wings of these lines, and we had completed the instrumentation to make quantitative measurements of the amplification in the wings. It appears likely that whether this emission appears in the red or blue wing is a sensitive function of the conditions.

This Contract ended at the time the emission pulses from excited sodium were confirmed, and the apparatus for quantitative measurement of light amplification was being set up and tested. The research has continued without formal support at a marginal level, since the conclusion of this Contract, with the goal of establishing the conditions for light amplification and finding how much amplification is occurring. The apparatus to do this was in part purchased with funds from this Contract and in part with apparatus, such as lasers, that we had or could put together with equipment at hand.

The report of the kinetic study is now being prepared for publication.

It is our intent to submit a new proposal to ARO. This proposal will include research in new but related areas, basic research directly related

to the topic of the Contract just concluded and, depending on the outcome of the work now in progress, development of the ion-ion recombination laser along the lines suggested in our last Proposal.

Participating Personnel

R. Stephen Berry, Principal Investigator

Joseph Weber (completed doctoral oral examination during Contract period; will receive Ph.D. in next Academic Quarter);

Tetsushi Noguchi, laboratory assistant;

Michael Mozurkewich, graduate student.